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Mission Highlights

STS-69

IS-1995-09-001.069JSC
September 1995

Double deploy and retrieval another shuttle first

Completion of Space Shuttle *Endeavour's* ninth mission marked another first in human space exploration. The five-member crew, successfully deployed and retrieved two free-flying satellites.

During the mission, while separated from the Orbiter by a distance of about 40 nautical miles, the SPARTAN solar physics free-flyer spent about 48 hours observing the solar corona and the solar wind to determine its effects on Earth-bound communications. The free flyers's White Light Coronagraph instrument obtained spectacularly good data over 95 percent of the planned sequence of studying the Sun's northern polar regions.

The Wake Shield Facility grew thin films for semiconductor and electrical component use. During Wake Shield's three days of free flight, four of seven possible epitaxial film runs were successfully completed.

A 6 hour, 46 minute space walk to test new thermal space suit improvements and some tools and techniques for the International Space Station (ISS) assembly capped off the nearly 11 day mission. The EVA had astronauts Mike Gernhardt and Jim Voss each spending 45 minutes on the end of *Endeavour's* mechanical arm as Jim Newman maneuvered them away from the radiated warmth of the payload bay. With the shuttle's payload bay pointed away from the Sun, the space walkers were exposed to temperatures as low as minus 120 degrees Fahrenheit during the "cold soak" evaluation. Suit improvements included thermal socks, insulated boots, heaters in the glove fingers and

As part of a space walk, Mission Specialist Mike Gernhardt performs a series of equipment checkouts while attached to *Endeavour's* Remote Manipulator System.

Space Shuttle *Endeavour*

September 7-18, 1995

Commander:	Dave Walker
Pilot:	Ken Cockrell
Mission Specialists:	Jim Voss Jim Newman Mike Gernhardt

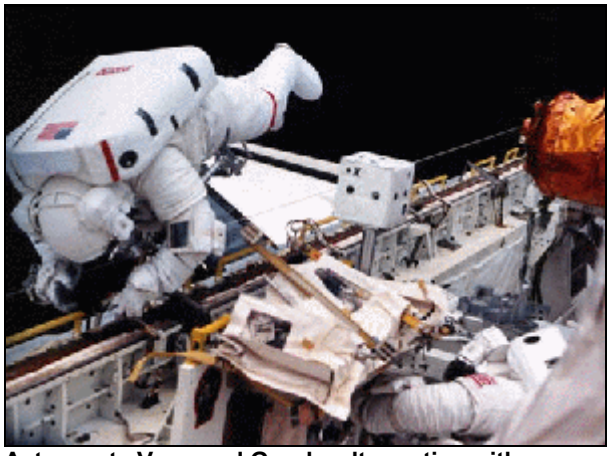
an ability to shut off the flow of cooling water to their extremities in frigid conditions.

The mission had been delayed to enable engineers to solve the presence of air pockets in a nozzle joint of the shuttle's solid rocket motors. "Safety of flight, is, and will be, our primary concern," said Brewster Shaw, director of shuttle operations. The Kennedy Space Center and Morton Thiokol teams worked diligently to ensure a safe and successful launch on Thursday, September 7, 1995.

Mission Events

Following a 10:09 a.m. CDT launch, the *Endeavour* crew prepared the Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN) spacecraft and the Wake Shield Facility for deploy-ment. The crew, which adopted the moniker the "Dog Crew," was awakened on Friday with Elvis Presley's "You Ain't Nothing But a Houndog," to begin their first full day in space. At 10:42 a.m. CDT, Mission Specialist Mike Gernhardt released the 2,800 pound SPARTAN free flyer from the shuttle's robot arm. On the flight deck, Commander Dave Walker and Pilot Ken Cockrell initiated two separation burns to move *Endeavour* away from the satellite. Crew members also were kept busy with a wide variety of payloads housed both on the orbiter's middeck and in the cargo bay.

On Saturday, crew members monitored the progress of SPARTAN and conducted work with the shuttle glow (GLO) experiment in the cargo bay.



Astronauts Voss and Gernhardt practice with equipment in *Endeavour's* cargo payload bay.

This experiment was designed to measure the luminescence created around the shuttle as it plows through atomic oxygen in low-Earth orbit at a speed of five miles a second. They also monitored several experiments in the middeck area which were designed to capture data on materials and life science. As they passed over the Atlantic at the start of their 31st orbit, the astronauts downlinked video of Hurricane Luis swirling with maximum sustained winds of 109 miles an hour.

The work day was used to grapple the SPARTAN solar science satellite at 10:02 a.m. CDT concluding the craft's study of the solar corona and the solar wind. The crew then prepared the Wake Shield Facility for deployment.

On Monday, the Wake Shield was successfully deployed at 6:25 a.m. CDT 250 miles over western Africa. Trailing behind *Endeavour* by just over 14 nautical miles, the two-ton Facility began its first thin film processing run at 3:33 p.m. CDT. Payload controllers successfully commanded the Wake Shield through a series of activities to prepare its surface for the epitaxial film growth process, handing command duties over to Mission Specialist Newman when *Endeavour* moved out of range of the Tracking and Data Relay Satellite System.

The mission proceeded with the manufacture of thin film compounds for improved semiconductor and electrical component use. However, about 7 a.m. CDT the 4,300 pound, saucer-shaped satellite put itself in a safe mode after three successful growths of thin films. Wake Shield's systems were temporarily shut down to allow temperatures to cool.

While Wake Shield operations were restored on Wednesday, Gernhardt and Voss conducted a thorough checkout of the space suits to be used during their space walk.

The *Endeavour* crew successfully retrieved the Wake Shield Facility on Thursday. After Walker and Cockrell maneuvered *Endeavour* alongside the satellite, Newman reached out with the shuttle's robot arm and plucked it from orbit. The capture came at 8:59 a.m. CDT, with berthing of Wake Shield back in its carrier platform at 10:18 a.m. CDT. Prior to capturing Wake Shield, Walker and Cockrell performed a series of 14 thruster firings at distances of 290 and 200 feet, respectively. These jet firings were designed to gather data on the effect of thruster plumes against orbiting space structures. Sensors on the satellite successfully measured the force and pressure of the jet plumes.

On Friday, the Wake Shield was unberthed and placed over the side of *Endeavour's* cargo bay at the end of the robot arm to conduct the CHAWS (Charging Hazards and Wake Studies Experiment). CHAWS is an Air Force-sponsored experiment designed to collect data on the buildup of electrical fields around an orbiting space vehicle. Engineers use the information to better understand how the ionized particles interfere with spacecraft communications and the operation of orbiting spacecraft. After about five hours of data-gathering, Newman maneuvered the satellite back down onto its berthing platform where it was latched in place to wrap up the Wake Shield's scientific investigations.

On Saturday, at 3:20 a.m. CDT, Voss and Gernhardt floated out into *Endeavour's* cargo bay beginning a six and a half hour space walk designed to test new thermal improvements made to their space suits and the tools and techniques to be used in the assembly of the ISS. The space walkers installed thermal sensors on the shuttle's robot arm and at a work site mounted on the starboard wall of the payload bay. The sensors measured temperature levels in the cargo bay to provide data on how hot and cold the space walkers were as they performed their work.

The pair also removed a debris shield from the work site, manipulated a duplicate of a computer control box for a robot arm under development for the ISS and tested new helmet lights and suit heaters as they maneuvered around the cargo bay with relative ease. Gernhardt and Voss each spent 45 minutes on the end of *Endeavour's* mechanical arm as Newman maneuvered them away from the radiated warmth of the payload bay. With the shuttle's

payload bay pointed away from the Sun, the space walkers were exposed to temperatures as low as minus 120 degrees Fahrenheit for a "cold soak" evaluation. Temperature measurement devices mounted on the robot arm and in the payload bay provided objective data to correlate with the space walkers' evaluations. Voss and Gernhardt reported that they were very comfortable, both during their cold soak evaluation and as they worked through a series of repetitive tool-handling tasks in the payload bay.

Preparations for the return home began on Sunday as the crew repacked equipment and checklists that were used during 10 days of on-orbit activity. *Endeavour* glided to a smooth touchdown at the Kennedy space Center at 6:38 a.m. CDT to complete a nearly 11-day mission.

Additional Payload Descriptions

Wake Shield Facility-2 (WSF-2): The WSF is a 12-foot diameter, stainless steel disk designed to generate an "ultra-vacuum" environment in space within which to grow thin films for next generation advanced electronics. The commercial applications for high quality semiconductor devices are most critical in the areas of cellular telephones, high-speed transistors and processors, high-definition television, fiber optic communications and opto-electronics. Results from this and other WSF flights may have a significant impact on the micoroelectronics industry because the use of advanced semiconducting thin film materials in electronic components holds a promising economic advantage. Epitaxy, the growth of atomically ordered thin films in a vacuum environment, is one method of generating such advanced materials. A prime barrier to improving epitaxial films is the limit on the quality of the vacuum that can be generated in an industrial growth chamber. To improve the material, the vacuum in which it is grown must be improved. The vacuum of space can make this improvement possible.

The WSF was designed, built, and managed by the Space Vacuum Epitaxy Center (SVEC) based at the University of Houston. Its principle industry partner was Space Industries, Inc. (SII), League City, TX.

The Global Positioning System (GPS) was a dual mode experiment from the University of Texas at Austin using a GPS receiver to determine precision position and velocity of the WSF and employing GPS signal strength attenuation to determine atmospheric temperature profiles.

The Shuttle Plume Impingement Experiment was a complex interaction between shuttle jet firings and space structures. A complex series of shuttle thruster firings at a variety of distances from the WSF were developed to use the WSF's response to measure the characteristics of the shuttle's thruster plumes.

Mission Specialist Cockrell (left) and Commander Walker (center) conduct experiments on the aft flight deck.

The Cosmic Dust and Orbital Debris Experiment Monitor (CoDEM) was a Baylor University Space Science Laboratory experiment that collected and characterized the new WSF environment with in-situ measurements of dynamic and physical characteristics of particulate matter. The ensemble of detectors measured particle time-of-flight, impact plate plasma, and particle impact momentum. This experiment incorporated high sensitivity, high reliability integrated detectors into a package capable of returning captured materials for laboratory examination.

The Neutral Mass Spectrometer (NMS) was developed in a team effort by the University of Texas at Dallas and Lamar University at Beaumont, TX. This experiment tested a magnetic-sector field mass spectrometer designed to measure the ultra-vacuum created in the wake of the WSF.

The Earth Reference Attitude Determination System (ERADS) from Honeywell Satellite Systems, used Earth and Sun sensors in combination on the rim of the WSF. The sensor has an annular field of view which permitted Earth limb and star field viewing.

The Hyper Velocity Impact Capture Experiment, developed by NASA's Jet Propulsion Laboratory, was a passive debris collection/exposure experiment used to measure space debris around the WSF and compare it to data collected on previous space flights.

The University of Toronto Institute for Aerospace Studies developed a **Materials Exposure Experiment** for collecting data on atomic oxygen interaction with various materials. The experiment exposed more than 150 samples of 26 different materials to the space environment to gather data on how this affects these materials.

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The Advanced Process Controller (APC) was a joint Space Industries and Space Vacuum Epitaxy Center venture for development and space qualification of a PC type process controller. Uses of the controller included the automated control of the commercial WSF.

The MagField Experiment undertaken by 10th grade students at Gregory Jarvis High School in Mohawk, NY, determined the variation of the Earth's magnetic field from magnetometer and electron diffraction data obtained during the WSF mission. The students worked with Space Vacuum Epitaxy Center researchers in applying the

WSF magnetic field data to the identification of variations of the Earth's magnetic field from that of an ideal magnetic dipole field.

SPARTAN 201-03 was a scientific research effort aimed at investigating the interaction between the Sun and its outflowing wind of charged particles. Scientific instruments on SPARTAN were the Ultraviolet Coronal Spectrometer (UVCS) and the White Light Coronagraph (WLC). The UVCS was used to measure characteristics of the light emitted by neutral hydrogen atoms in the solar corona. It also measured the brightness of light emitted by hot, highly charged atomic ions. This device was developed by the Smithsonian Astrophysical Observatory, Cambridge, MA.

The WLC is a specialized telescope that produces an artificial eclipse of the Sun so that the constantly-changing shape and form of the solar corona can be imaged. The experiment was operated by the Goddard Space Flight Center and was developed by the High Altitude Observatory, Boulder, CO.

International Extreme Ultraviolet Hitchhiker (IEH-1): Measured and monitored long-term variations in the magnitude of absolute extreme ultraviolet (EUV) flux coming from the Sun, and studied EUV emissions from the plasma torus system around Jupiter originating from its moon Io. These observations were accomplished by the two complementary experiments that comprise IEH, the Solar Extreme Ultraviolet Hitchhiker (SEH) and the Ultraviolet Spectrograph Telescope for Astronomical Research (UVSTAR).

SEH and UVSTAR were international cooperative investigations. International partners in IEH-1 from the Italian Space Agency studied the EUV emission of hot stellar objects. The NASA portion of the science was sponsored by the Solar System Exploration Division, NASA Headquarters.

The Combined Capillary Pumped Loop-2/Gas Bridge Assembly (CAPL-2/GBA) consisted of the CAPL-2 Hitchhiker payload designed as an in-orbit microgravity demonstration of a cooling system planned for the Earth Observing System Program and the Thermal Energy Storage-2 payload, part of an effort to develop advanced energy generation techniques.

Commercial Materials Development and Instrumentation Technology Associates Experiments (CMIX-4): The objectives of this experiment included analysis of cell change in microgravity along with studies of neuro-muscular development disorders. Slowing of cell growth in microgravity provides important insight into cell changes on Earth and may lead to therapeutic measures to counter cell growth inhibition, loss of bone mass and impaired immune function. Research also focused on neuro-muscular development disorders which are of interest to the industrial pharmaceutical and biotechnical research communities.

Astronaut Jim Newman utilizes an onboard computer work station.

The CMIX experiments included: **The Commercial Generic Bioprocessing Apparatus-7 (CGBA-7)** an incubator and data collection point for experiments in pharmaceuticals testing and biomedicine, bioprocessing and biotechnology, agriculture and the environment.

Other experiments were associated with plant cell growth. Pharmaceutical products from plants have been used for treatment of various types of cancer.

Instrumentation Technology Associates, Inc. (ITA's) portion of the mission concentrated on three research activities: the growth of protein crystals emphasizing urokinase protein crystals; microencapsulation of drugs; and the ITA student space education program.

If the structure of the urokinase protein crystal can be established, an inhibitor drug can be developed to combat breast cancer metastasis. To date, no ground-based research effort has provided urokinase crystals of sufficient size to effectively analyze.

ITA also worked with its partners to explore a drug delivery system to better target the intervention area of tumors without affecting surrounding healthy tissues. These research efforts have considerable potential for the pharmaceutical industry and medical provider community.

Another major effort was ITA's student space experiment outreach program which donates a percentage of the CMIX payload flight hardware and technical support to selected university and high school projects as a means of fostering an interest in the field of space technology.

Bacteriorhodopsin Polymerization: Bacteriorhodopsin-based memories offer the promise of exceptionally high data storage densities for future computer applications. Principal investigators were the Center for Molecular Electronics and the University of Syracuse, NY.

Water Purification: This experiment attempted to determine if a combination of silver and copper resin materials would be effective in disinfecting pseudomons bacterial contamination. In addition to water purification applications in space, spinoff products have already found wide use in industry for a variety of water purification applications. The principal investigator was Kansas State University.

Bone Cell Growth in Space: Data gathered from this experiment contributed to the understanding of immune suppression. The principal investigator was Kansas State University.

Stabilization and Activation of Cells in Space: A colony of cells can be "stabilized" prior to launch, "activated" in orbit and, finally, "stabilized" again prior to its return to Earth. Applications may provide for a variety of unique disease treatments as it may

be that desired groups of diseased or cancerous cells can be stabilized and subsequently reactivated such that drugs can be delivered to the cells when they are most receptive to them. This has the promise of considerably increasing the effectiveness of existing drugs and therapies. The principal investigator was Kansas State University.

Biological Research in Canister-06 (BRIC-06): Examined slime mold cultures for specific chemical concentrations that are signs of the signal transduction process. The principal investigator was the German Aerospace Research Establishment. The experiment was sponsored by the Office of Life and Microgravity Sciences and Applications, Washington, DC.

Consortium For Materials Development In Space Complex Autonomous Payload (CONCAP IV-03): This experiment studied the growth of organic nonlinear optical crystals and thin films. The materials used were of great interest because they can be used in the photonics industry. Photonics is the use of laser light instead of electrons through wires to send bits of infor-mation. The advantage of photonics is the elimination of mechanical components, switches, and wear items, and the increased speed of information transferal that lasers offer. CONCAP IV-03 is managed by the Consortium for Materials Development in Space at the University of Alabama at Huntsville.

Thermal Energy Storage (TES): TES was designed to provide data for understanding the long-duration behavior of thermal energy storage fluoride salts that undergo repeated melting and freezing in micro-gravity. It flew as a Complex Autonomous Payload managed by the shuttle Small Payloads Project at Goddard Space Flight Center, Greenbelt, MD.

The Microgravity Smoldering Combustion (MSC): Focused on one-dimensional smoldering of polyurethane foam. The objective was to provide a better understanding of the controlling mechanisms of smoldering, both in microgravity and Earth gravity. The University of California, Berkeley, was the principal investigator for the MSC experiment which was conducted in conjunction with NASA's Lewis Research Center.

National Institutes Of Health-Cells 4 (NIH-C4): These experiments were conducted to study the effect of space flight on bone cell formation and loss during space flight. Weightlessness results in bone loss similar to that occurring in people who undergo prolonged bed rest or, in some cases, lose the use of one of their limbs due to injury or disease. Results from this experiment will help determine the usefulness of cultured bone cells in understanding how gravity functions to maintain bone cell activity. The principal investigator was the Mayo Clinic, Rochester, MN. The NIH-C4 payload was sponsored by NASA's Office of Life and Microgravity Sciences and Applications and the National Institute of Arthritis and Musculoskeletal Diseases.

In-flight crew portrait. Front row (L to R) Ken Cockrell, Dave Walker. Back row Michael Gernhardt, Jim Newman and Jim Voss.

CREW BIOGRAPHIES

Commander: David M. Walker (Capt. USN). Walker, 51, was born in Columbus, GA, but considers Eustis, FL, to be his hometown. He received a bachelor's degree from the U.S. Naval Academy. He also received flight training from the Naval Aviation Training Command at bases in Florida, Mississippi and Texas. He was next designated a naval aviator and proceeded to the Naval Air Station in Miramar, CA, for assignment to F-4 Phantoms aboard the carriers USS Enterprise and USS America. He then attended the USAF Aerospace Research Pilot School at Edwards Air Force Base, CA.

With the completion of STS-69, Walker has logged a total of 724 hours in space. His first flight was as pilot of STS-51A in 1984, which deployed Canada's Anik D-2 satellite and Hughes' LEASAT-1 satellite, and carried the first space salvage mission by retrieving the Palapa B-2 and Westar VI satellites for return to Earth.

Walker's second mission was STS-30 in May 1989 which deployed the Magellan probe. Most recently, he commanded STS-53 in November/December 1992, which deployed a classified Department of Defense payload and then performed several Military-Man-In-Space and NASA experiments.

Pilot: Ken Cockrell. Cockrell, 45, is a native of Austin, Texas. He received a bachelor's degree in mechanical engineering from the University of Texas, and a master's degree in aeronautical systems from the University of West Florida.

Cockrell received his commission through the Naval Aviation Reserve Officer Candidate Program at the Naval Air Station at Pensacola, FL, and was designated a naval aviator. He resigned his commission to join JSC as an aerospace engineer and research pilot at Ellington Field, Houston, serving as an instructor pilot and functional check pilot in NASA T-38 aircraft.

Cockrell's first space flight in April 1993 was STS-56, the ATLAS-2 mission, on which atmospheric and solar studies were conducted to better understand the effect of solar activity on Earth's climate and environment. With the STS-69 mission, Cockrell had logged more than 476 hours in space.

Payload Commander/Mission Specialist: Jim Voss (Lt. Col. USA). Voss, 46, was born in Cordova, AL, but considers Opelika, AL, to be his hometown. He has a bachelor's degree in aerospace engineering from Auburn University and a master's degree in

STS-69 Quick Look

Launch Date: September 7, 1995
Time: 10:09 a.m. CDT
Site: KSC Pad 39A

Orbiter: *Endeavour* OV-105 9th flight
Orbit/In.: 200 naut. miles 28.45 degrees

Mission Duration: 10 days, 20 hrs, 29 minutes
Landing Date: Sept. 18, 1995
Time: 6:38:55 a.m. CDT
Site: Kennedy Space Center

Crew: Dave Walker, (CDR)
Ken Cockrell, (PLT)
Jim Voss, (MS1)
Jim Newman, (MS2)
Mike Gernhardt, (MS3)

Cargo : Bay Payloads: Wake Shield
SPARTAN-201
IEH-01
CAPL/GBA

Middeck Payloads: BRIC
CGBA
CMIX
EPICS
STL/NIH-C

aerospace engineering sciences from the University of Colorado. After attending the U.S. Naval Test Pilot School at the Armed Forces Staff College, Voss was assigned to the U.S. Army Aviation Engineering Flight Activity.

Voss' first mission, STS-44 in November 1991, included the deployment of a Defense Support Program satellite. His second mission was STS-52 in December 1992 during which a classified Department of Defense payload was deployed. With the completion of STS-69, Voss had logged more than 600 hours in space.

Mission Specialist: Jim Newman, (Ph.D.). Newman, 38, was born in the Trust Territory of the Pacific Islands, but considers San Diego, CA, to be his hometown. He graduated cum laude with a bachelor's degree in physics from Dartmouth College and received a master's and doctorate in physics from Rice University.

Newman's first mission was STS-51 in September 1993 which deployed the Advanced Communications Technology Satellite and the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer on the shuttle Pallet (SPAS) Satellite. Following STS-69, he had logged 496 hours in space.

Mission Specialist: Michael L. Gernhardt (Ph.D.). Gernhardt, 39, was born in Mansfield, Ohio, and received a bachelor's degree in physics from Vanderbilt University, and master's and doctorate degrees in bioengineering from the University of Pennsylvania.

In 1988, Gernhardt founded Oceaneering Space Systems, a wholly owned subsidiary of Oceaneering International. He also worked on the development of new astronaut and robot-compatible tools for performing maintenance on the ISS, and the development of new portable life support systems and decompression procedures for extravehicular activities. Following the STS-69 mission, he had logged 260 hours in space.

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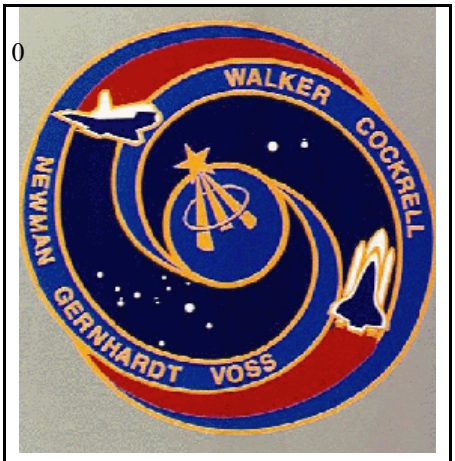

The STS-69 crew patch symbolizes the multifaceted nature of this mission. The primary payload, the Wake Shield Facility, is represented in the center of the patch by the astronaut emblem against a flat disk. The astronaut emblem also signifies the importance of humans in space exploration, reflected by the space walk supporting space station assembly.

The two stylized shuttles highlight the ascent and entry phases of the mission and, along with the two spiral plumes, symbolize a NASA first: the deployment and recovery on the same mission of two spacecraft, Wake shield and SPARTAN.

The constellations Canis Major and Canis Minor represent the astronomy objectives of the Spartan and International Extreme Ultraviolet Hitchhiker (IEH) payload and symbolize the talents and dedication of the support personnel who make space shuttle missions possible.